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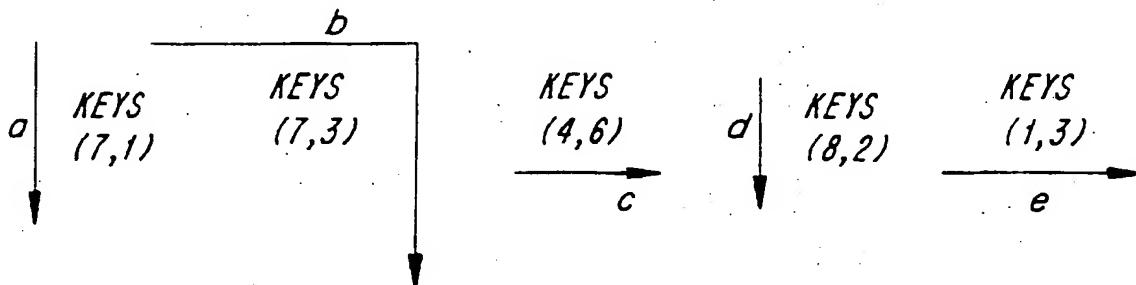
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(54) Title: METHOD OF INPUTTING CHARACTERS WITH A NUMERIC KEYPAD



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(57) Abstract: A method of using a computer keyboard to enter characters of a character-based language, such as Chinese, by entering pairs of keys corresponding to the penstrokes making up the character. Each penstroke may be represented by a pair of keys on the keyboard which have a spatial and/or relative orientation corresponding to the endpoints of the penstroke. The pairs of keys are then inputted to the computer in the same order as the sequence of penstrokes made in writing the character, since a particular Chinese character typically has a certain sequence of penstrokes. Alternatively, each penstroke may be represented by entering a single key on the keyboard. In this alternative embodiment, the single key entered has a relative orientation corresponding to the endpoints of the penstroke. Upon entry of each penstroke, a comparison is made to determine whether any statistically significant matches can be made indicating the desired Chinese character to be entered.

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METHOD OF INPUTTING CHARACTERS WITH A NUMERIC KEYPAD

Background of the Invention

5 **Field of the Invention**

The present invention generally pertains to systems for inputting languages, and more particularly involves a computer system for inputting characters of a character-based written language based on user entries to a standard keyboard or keypad.

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Background Information

In general, information may be entered with ease into a computer using an alphabet-based written language. For instance, the twenty-six letter alphabet of the English language lends itself particularly well to keyboard entry. By contrast, 15 entering characters of a character-based language such as Chinese is particularly problematic.

One difficulty of entering Chinese into computers is largely due to the multitude of characters which make up the written Chinese language. Including characters from seldom used dialects, there are as many as fifty thousand characters 20 in written Chinese. Modern, commonly used Chinese is said to include about six to eight thousand characters, with about half of this amount making up the vast majority of written Chinese communication. That is, about three thousand Chinese characters make up the "every day" written Chinese language accounting for nearly ninety-eight percent of the total usage. The difficulty of entering written Chinese 25 into a computer stems from the fact that three thousand characters will not fit onto a reasonably sized computer keyboard. A keyboard having three thousand character keys would be unmanageably enormous.

Another problem associated with inputting character-based languages such as Chinese, is that the characters themselves often have very complex configurations,

unlike the letters of the English alphabet. Chinese characters all tend to be about the same size, fitting into an imaginary "box," regardless of how many penstrokes make up the Chinese character. Another subtle feature of Chinese characters which adds to the complexity of written Chinese is the width of the penstrokes. For a 5 given Chinese character there may be a significance attached to the width of the penstrokes, some penstrokes being thicker or thinner or of varying thickness as compared to other penstrokes within the character. These attributes result in Chinese characters having a great number of penstrokes in rather complicated configurations.

10 For these reasons, the development of a practical, easy-to-use, conveniently sized keyboard has not yet been achieved for inputting Chinese characters. Several conventional approaches have been attempted, however, with varying degrees of success.

One conventional approach in overcoming the keyboard problem, has been 15 to use voice recognition systems for entering Chinese language characters into a computer system. Voice recognition systems eliminate the need to recognize complex Chinese characters with numerous intricate penstrokes. However, a problem with voice recognition systems is that there are a great number of different Chinese dialects, each having somewhat different pronunciations for a given 20 character. In fact, the same character may sometimes appear in completely different languages which have little or no pronunciation similarities. For instance, quite a number of Japanese characters are based upon Chinese characters, and thus appear the same in written form. However, the Japanese pronunciation of a character tends to be quite different from the Chinese pronunciation. Because of the various 25 pronunciations, different dialects, or different languages which can be associated with a given character, a voice recognition system typically requires an extensive learning period for a particular speaker to be able to enter Chinese characters by speaking them. In addition, the presence of background noise also causes problems, in general, for voice recognition system character entry.

Another conventional approach is to simply assign a number or letter value as a label for each Chinese character. This approach is disadvantageous because of the multitude of characters in the written Chinese language. A user would need to memorize as many as three thousand labels for Chinese characters, or use look-up 5 tables as a reference for the character labels. Thus, a system of labeling characters would require a great deal of effort on the part of a user to achieve proficiency in entering written Chinese.

Still, another conventional method is based upon a system of two-digit corner-shape codes which are arbitrarily preassigned to about thirty common corner 10 shapes of Chinese characters. According to this system, two-digit corner-shape codes are used to define three of the four corners of a Chinese character. The three two-digit numbers are then combined together to define the Chinese character. In this way, the Chinese character can be defined by a single six digit number made by combining together three two-digit corner-shape codes. One disadvantage of this 15 system is that a certain amount of duplication exists since some characters have three corners which look the same. Another disadvantage is that a user must memorize about thirty different two-digit codes corresponding to thirty different corner shapes of Chinese characters.

One other conventional approach was suggested in U.S. Patent No. 20 5,109,352 ("O'Dell"). Like the system described above which assigns two-digit codes to different types of character corners, O'Dell also relies on a system of codes correlated to partial characters. These partial characters are formed together in penstroke sequence in order to construct a complete Chinese character. The O'Dell device also suffers from the drawback of requiring a user to memorize a fair number 25 of the codes correlating to partial characters. U.S. Patent No. 5,790,055 (Yu) and U.S. Patent No. 5,724,031 (Huang) are similar to O'Dell in that each of these Chinese character input systems is based upon penstrokes or sub-character portions correlated to codes which must be memorized by a user, and formed together to construct a complete Chinese character.

Yet another conventional Chinese character input system, U.S. Patent No. 5,893,133 (Chen), relies upon the entry of keyboard characters which represent phonetic Chinese (i.e., Pin Yin). The Chen system suffers from the drawback of numerous dialects with different pronunciations for the same Chinese character, 5 much like the problems encountered with voice recognition systems.

Therefore, a system for inputting Chinese characters, and more generally, a system for inputting character-based written languages, is greatly needed.

Summary of the Invention

10 One disadvantage of conventional systems is that users typically must first memorize a predetermined numbering scheme for entering various shapes making up Chinese characters. Exemplary embodiments of the present invention provide an improved system for entering Chinese characters via a keyboard, without requiring a user to memorize a predetermined numbering scheme. According to embodiments 15 of the present invention, the keyboard is used for entering features of a penstroke of the character, such as the endpoint orientation of the character. For instance, the keyboard is used as a sensor to detect the spatial and/or relative orientation of the two penstroke endpoints, wherein the penstroke endpoints are represented by two keyboard keys. The present invention may be used to enter written characters into a 20 computer, a terminal, a typewriter or like data entry device, via a keyboard.

According to a first embodiment of the present invention, a desired character is entered by a user via the keys of a keyboard. The user enters penstrokes by depressing two keys representing the two endpoints of each penstroke of the desired character. The relative position on the keyboard of each of the two keys 25 representing a penstroke corresponds to the relative position of each of the two endpoints of the penstroke. Upon entry of each penstroke, the computer determines potential matches to the desired character, if any, based upon the penstrokes entered so far. If the computer determines any potentially matching characters, the user is given the option of selecting the desired character from among the potentially

matching characters, if the desired character is present. The user may continue to enter key pairs representing penstrokes until the desired character is determined. In addition, to determine potentially matching characters, the computer identifies those characters which are statistically significant with respect to a predetermined 5 threshold. The potentially matching characters may then be displayed to the user, allowing the user to select the desired character. The user may also be prompted to perform a penstroke adjustment routine, in order to move, resize, or reposition the penstroke.

According to a second embodiment of the present invention, a user may a 10 enter a desired character via a keyboard by depressing a single key for each penstroke to be entered. The user enters a key of the keyboard to indicate the second of two endpoints associated with the penstroke. The first of the two endpoints is understood to be represented by a designated key.

According to a further embodiment of the present invention, the two keys 15 representing the penstroke endpoints have a relative and a spatial relationship with respect to the keyboard which corresponds to the relative and spatial relationship of the penstroke with respect to the desired character.

According to a further embodiment of the present invention, if the penstroke has a curve, one or more keys may be entered to represent parameters the penstroke 20 in addition to the keys representing the penstroke endpoints. The additional key or keys may be associated with the curve in the penstroke, indicating its direction, for instance.

According to the aforementioned embodiments of the present invention, the invention encompasses the software which executes the steps of the invention on a 25 computer, as well as the method of performing entry of the desired character.

Brief Description of the Drawings

Other objects and advantages of the present invention will become apparent to those skilled in the art, upon reading the following Detailed Description of

Preferred Embodiments in conjunction with the accompanying drawings, wherein like reference numerals have been used to designate like elements, and wherein:

FIGS. 1A-C are various types of keypads and keyboards;

FIG. 2 is a Chinese character showing penstroke sequence;

5 FIG. 3 is a flowchart of a method of the present invention;

FIG. 4 depicts a flow chart of an embodiment which allows adjustment of penstrokes entered;

FIG. 5A depicts a keypad sequence for the restrictive direct geometric mode of the present invention;

10 FIG. 5B depicts a keypad sequence for the non-restrictive indirect geometric mode of the present invention; and

FIG. 5C depicts the keys corresponding to penstrokes for entering the character of FIG. 2 according to a second embodiment of the present invention.

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Detailed Description of the Preferred Embodiments

FIGS. 1A-1C are various keyboard configurations in common usage which can be used in conjunction with the present invention to input characters. The present invention can be used to input characters into keyboards of, for instance, computers, terminals, word processors, typewriters, calculators, telephones, data entry devices, control panels, or like devices having a keyboard. The keyboard may be in the form of a keypad, keys, or any control logic/data entry configuration consisting of a plurality of proximately located buttons, switches or data entry devices.

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Examples of typical keyboards are shown in FIGS. 1A-1C. FIG. 1A

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depicts a telephone keypad commonly found on DTMF (dial tone multi-frequency) based land-line phones, and on cellular and wireless telephones as well. FIG. 1B depicts the configuration of a keypad often found on calculators, adding machines, or the numerical entry portion of computer keyboards. FIG. 1C depicts a typical alphanumeric keyboard, commonly found on computers and typewriters.

FIG. 2 is an exemplary Chinese character, and it is used in the discussion herein for the purpose of explaining the present invention. Although the present invention is explained in terms of inputting a desired character which is a Chinese character, the present invention may be used in conjunction with any character-based language or system of symbols, and is not limited to only Chinese.

A penstroke is a line made in writing a character-base language character, such as a Chinese character. For instance, to write a Chinese character, a person makes a number of penstrokes in a particular sequence to form the proper configuration of the character. Penstrokes may be straight lines or curved lines, and have a number of features associated with them. In describing penstrokes in the context of the present invention, a "curved" line is defined to have a rounded curve or a bent curve. A bent curve is intended to be a "corner" shape which looks like two straight (or slightly rounded) lines intersecting at a corner which may have various corner angles. Penstrokes may be of different widths (e.g., some penstrokes are wide and some are narrow), or a particular penstroke may vary in width along its length. Each penstroke has two endpoints. The beginning endpoint is where the line begins (i.e., where the pen is first applied to the paper) and an ending endpoint where the line ends (i.e., where the pen is removed from the paper). Alternative to being a line in a character based language, a penstroke may also be a line made in writing a symbol such as a mathematical symbol, a musical note, a proofreader's mark, a chemistry symbol, a monetary symbol, a livestock brand, or other like symbol (e.g., "+", "=", " \leq ", " \sum ", "b", "☆", "✓", "σ", "♡", "♀", "£", "†", "§", "◊", etc.).

For hand-written character based languages, there is typically a proper sequence of penstrokes to form particular characters, and a proper motion for making a particular penstroke. For instance, in China students are taught the proper sequence of penstrokes for writing each character. Students are also taught the proper motion for forming a penstroke, or penstroke execution order, for each penstroke (i.e., the sequence of the two endpoints within a penstroke, or motion in

making a particular penstroke). Some minor differences may exist in penstroke sequence or penstroke execution order, due to regional customs. For the most part, however, the penstroke sequence and penstroke execution order are fairly uniform for a given character. The present invention exploits the known sequence of 5 penstrokes, with provisions for possible sequence variations, by identifying a character being entered based upon penstroke sequence, wherein each penstroke is defined by the orientation of its endpoints.

In FIG. 2, each of the penstrokes making up the Chinese character are labeled so as to illustrated the proper penstroke sequence (i.e., in the order that the 10 penstrokes are performed when writing the character). Accordingly, the penstroke labeled "a" is the first penstroke made when writing the character of FIG. 2. Penstroke "b" is the second penstroke in the penstroke sequence, and so on. FIG. 2 also indicates, using arrows for each penstroke, the proper penstroke motion. As 15 will become apparent in the ensuing discussion, the present invention exploits the uniform penstroke sequence and/or the penstroke motion for the purposes of Chinese character recognition.

Through use of the present invention, penstrokes associated with a character from a character-based language, such as Chinese, may be entered into a computer or like data entry device via a keyboard. Rather than assigning a numerical code to 20 each particular penstroke shape, as in some conventional methods, the keyboard is used as a sensor to detect the spatial orientation of the two penstroke endpoints with respect to the keyboard. According to one embodiment of the present invention, penstrokes are represented by two keyboard keys. One key represents each endpoint of the penstroke. For instance, penstroke "a" of FIG. 2 may be entered by 25 pressing key 7 and then pressing key 1, of the numeric keypad in FIG. 1B. Key 7 is pressed before key 1 since the motion of penstroke "a" is made from top to bottom, as indicated by the arrow on FIG. 2 for penstroke "a." Penstroke "b" may be entered by pressing key 7, and then pressing key 3 of the FIG. 1B numeric keypad. Likewise, according to this embodiment, the penstrokes of the FIG. 2

labeled "c", "d", and "e" may be entered as keyboard key pairs (4, 6), (8, 2), and (1, 3), respectively.

Although this example uses key from a numerical keypad, the present invention is not limited thereto. Any keys may be used for entry of penstrokes, 5 e.g., alphanumeric, punctuation or symbol keys. According to another embodiment of the present invention, a penstroke may be entered by depressing a single key which represents the second endpoint, the first endpoint being represented by a predetermined, designated key which need not be depressed. One advantage of the present invention over the various conventional systems is that it is much easier to 10 designate penstrokes by the keyboard keys corresponding to the spatial orientation of the penstroke endpoints, rather than memorizing a list of codes for various shapes of penstrokes.

According a further embodiment of the present invention, curved penstrokes, including bent penstrokes, may be represented by three or more keyboard keys.

15 For instance, in addition to the two keys representing the penstroke endpoints, another key may be entered representative of a curve, or bend, of the penstroke, relative to the two endpoints. For instance, the additional key may describe the direction and/or the extent of the curve, or the direction and/or degree of the angle in a bend. For this further embodiment, straight line penstrokes may still be 20 represented by two keys (or alternatively, by one key), and curved penstrokes may be represented by entering one or more additional keys. A predetermined signal can be used in order to indicate to the computer that keys are being entered to signify the direction that the penstroke curves or bends relative to the two endpoints. For instance, another designated key can be entered following (or preceding, in another 25 embodiment) entry of the three keys representing the curved penstroke. This avoids the problem of having the computer interpret solely the first two keys as representing a penstroke, and treating the next key as part of another penstroke.

FIG. 3 is a flowchart of a method for a first embodiment of the present invention. In step S10 of FIG. 3, a user is prompted to select a penstroke entry

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mode to be used for entering a desired Chinese character. For instance, the user may specify a two-key penstroke entry mode in accordance with the first embodiment. In the two-key penstroke entry mode two keyboard keys represent the two endpoints of a penstroke. The user may further select a geometrically 5 restrictive mode, a geometrically non-restrictive mode, and/or other alternative modes of the present invention. The geometrically restrictive and geometrically non-restrictive modes of the present invention are explained further in conjunction with FIGS. 5A and 5B, respectively. In short, however, the geometrically restrictive mode is based upon entry of keyboard key pairs selected so that both 10 keys are positioned relative to each other in a manner corresponding to the penstroke endpoints, and both keys are also spatially oriented on the keyboard in a manner corresponding to the spatial orientation of the penstroke endpoints within the character. In the geometrically non-restrictive mode keyboard key pairs are selected which are positioned relative to each other corresponding to the penstroke 15 endpoints, but the key pair need not be spatially oriented on the keyboard like the penstroke endpoints within the character. Instead of selecting the first embodiment for penstroke entry, the user may select a one-key penstroke entry mode in accordance with a second embodiment. In the one-key penstroke entry mode one keyboard key is entered to indicate the second of two endpoints of a penstroke. The 20 first endpoint is understood to be designated by a predetermined key.

After the user selects the penstroke entry mode, the method proceeds to step S12 where the user is prompted to enter a first penstroke of the desired Chinese character to be entered, using the keyboard keys in accordance with the selected penstroke entry mode. For example, if the user selected the two-key penstroke entry mode in accordance with the first embodiment, two keyboard keys are entered to represent the two penstroke endpoints based upon the relative and/or spatial orientation of the keys in comparison to the two penstroke endpoints. 25

If in step S10 the user had selected the one-key penstroke entry mode of the second embodiment, then in step S12 one keyboard key is entered to represent the

second of two penstroke endpoints. In accordance with the second embodiment, the first endpoint is assumed to be represented by a designated keyboard key, e.g., key 5 of a numeric keypad. For each penstroke, the user enters the keyboard key corresponding to the second endpoint. The second endpoint key is oriented on the 5 keyboard in a manner corresponding to the relative orientation of the of the second penstroke endpoint to the first. For instance, if key 5 is the designated key representing the first endpoint, a downward penstroke (i.e., a vertical penstroke with the first endpoint being at the top and second endpoint at the bottom) may be entered in step S12 by depressing the 2 key, which is oriented directly below the 5 10 key.

A further embodiment, which may be performed in conjunction with the first or second embodiment as part of step S12, entails entering one or more keys in addition to the pair of keys which indicate the endpoints. The key or keys entered in addition to the endpoint keys signify parameters of the penstroke, such as the 15 direction that a penstroke is curved, or the penstroke width.

Upon completing step S12, a determination is made as to whether there is at least one statistically significant potential match between the penstroke data entered thus far, and a Chinese character. Of course, entering only one penstroke will be unlikely to result in a statistically significant match. However, it is not necessary 20 for all penstrokes of a character to be entered before a statistically significant match becomes evident. Also, the parameters of the present invention can be adjusted to raise or lower the level of statistical significance, thus producing either fewer or more potential matches for a given amount of entered penstroke data.

If one or more statistically significant potential matches are identified in 25 accordance with the "yes" path out of decision step S14, then potential matches determined to be statistically significant are displayed to the user per step S18. Then in step S20, the user determines whether the desired Chinese character is among the displayed potentially matching characters deemed to be statistically significant. If the desired character is displayed in accordance with the "yes" path

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out of decision step S20, the user can then select the desired character from amongst the characters being displayed in accordance with step S52. Upon selecting the desired character in step S52, the user is given the option in step S54 of starting the process over to enter another character, or ending the character entry process if 5 there are no further characters to be entered.

If no potential matches are identified in accordance with the "no" path out of decision step S14, or if potential matches are identified, but none are the desired character in accordance with the "no" path out of decision step S20, then, in accordance with step S16, the penstroke or penstrokes entered thus far are 10 displayed. The method then proceeds to step S22, where the user is queried as to whether another penstroke is to be entered. If the user opts not to enter another penstroke, the method proceeds to decision step S24 in accordance with the "no" path out of decision step S22.

In accordance with decision step S24, the user determines whether to adjust 15 any of the previously entered penstrokes. If the user does not wish to adjust a penstroke, the method proceeds from decision step S24 via the "no" path to decision step S26 where the user is given the option of starting the process over. If the user opts to start over, in accordance with the "yes" path to decision step S26 the method begins anew at step S10. However, if the user opts not to start over, in accordance 20 with the "no" path from the step S26, the method proceeds to step S50 for an indication that no match was found, then to step S99 where the process ends.

If the user does, in fact, wish to adjust a penstroke, in accordance with the "yes" path out of decision step S24, the method proceeds to the penstroke adjustment routine of step S30, where the user may make adjustments, using the 25 keyboard, to the penstroke or penstrokes entered so far. The penstroke adjustment routine in accordance with step S30 is discussed in further detail below, in conjunction with FIG. 4. After adjusting the penstrokes, in accordance with the penstroke adjustment routine of step S30, the method then proceeds to step S14 to determine statistically significant potential matches, if any.

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To enter a character, the method proceeds through these steps until the correct Chinese character is displayed and selected in step S52 by the user.

Decision step S54 is then performed to determine whether the user wants to enter another character. If the user wants to enter another character, the method proceeds 5 to decision step S10 via the "yes" path from decision step S54. If the user does not want to enter another character, the method proceeds to step S99 via the "no" path from decision step S54, where the method ends.

FIG. 4 depicts a flow chart of an embodiment which allows for the adjustment of penstrokes that have already been entered. The method depicted in 10 FIG. 4 corresponds to the step S30 penstroke adjustment routine of FIG. 3. Once one or more penstrokes have been entered, the method of the present invention may proceed to step S32 of FIG. 4 via the "yes" path from decision step S24.

In step S32 the user may scroll through all of the penstrokes entered so far. Upon reaching a penstroke in step S32 which the user wants to adjust, the user may 15 select that penstroke in accordance with the "yes" path out of decision step S34. The method then proceeds to decision step S38 where the user may select the adjustment operation of either moving, resizing, or repositioning the penstroke. If the user chooses to move a penstroke, the method proceeds to step S40 for the move penstroke subroutine. If the user chooses to resize a penstroke the method proceeds 20 to step S42 for the resize penstroke subroutine. If the user chooses to reposition a penstroke the method proceeds to step S44 for the reposition penstroke subroutine.

According to one embodiment, the adjustment of a penstroke in one of steps S40, S42 or S44 may be accomplished, for example, by entering two keys which are understood to correspond to the endpoints of the penstroke to be adjusted, then 25 entering two keys corresponding to the adjusted penstroke. Take, for example, the situation in which a user wants to move a vertical penstroke, displayed in the center of a character, to the left side of the character. In accordance with the move stroke routine of step S40, the user could first press key pair (8, 2) to represent the present position of the penstroke, and then press key pair (7, 1) to represent the desired new

position of the penstroke. In this way, the penstroke would be moved to the left. In a similar manner, adjustment according to step S42 or step S44 could be accomplished, for example, by entering two keys which are understood to correspond to the endpoints of the present position of the penstroke, then entering 5 two keys corresponding to the adjusted position of the penstroke. According to another embodiment, predetermined keys could be pressed to indicate the direction for moving the penstroke. For instance, key 8 could indicate upward movement, key 2 could indicate downward movement, and so on.

The method proceeds from the selected one of steps S40, S42 or S44, to 10 decision step S46, where the user is given the option of adjusting another penstroke, or further adjusting the same penstroke. If the user opts to adjust another penstroke, the method proceeds to step S32 to scroll through the penstrokes entered so far, in accordance with the "yes" path from decision step S46. If the user opts not to adjust another penstroke, the method proceeds to step S14 of FIG. 3 to 15 determine statistically significant potential matches, if any, in accordance with the "no" path from decision step S46.

FIG. 5A depicts key pairs corresponding to penstrokes for entering the character of FIG. 2 according to the restrictive direct geometric mode of entry which may be used in conjunction with the two-key penstroke entry method of the 20 first embodiment, as stated above. According to the restrictive direct geometric mode, two keys are selected with both keys being positioned relative to each other in a manner corresponding to the endpoints of the written penstroke, and both keys also being spatially oriented on the keyboard in a manner corresponding to the spatial orientation of the penstroke endpoints within the character. In other words, 25 the position of the first key with respect to the second key corresponds to the position of the first penstroke endpoint with respect to the second endpoint (i.e., corresponding relative positioning), and the position of the first and second keys with respect to the keyboard corresponds to the position of the first and second

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penstroke endpoints with respect to the desired character (i.e., corresponding spatial positioning).

For example, to represent a vertical penstroke along the full left side of the character, e.g., penstroke "a" of FIG. 2, it would be appropriate for the user to 5 select the key pair (7, 1) on the keyboard illustrated in FIG. 1B, since the "7" key and the "1" key pair are vertical relative to each other and are located along the left side of the keypad, like the "a" penstroke. Note that the "7" key is selected first, then the "1" key, since the penstroke "a" is drawn in a downward direction.

In a similar manner, penstroke "b" of FIG. 2 could be entered as key pair (7, 10 3); penstroke "c" could be entered as key pair (4, 6); penstroke "d" could be entered as key pair (8, 2); and penstroke "e" could be entered as key pair (1, 3). Thus, all penstrokes of the Chinese character depicted in FIG. 2, could be entered into a computer using the restrictive direct geometric mode according to the present invention by typing in the ten-digit number string "7173468213" to represent the 15 five penstrokes making up the character. Of course, it may not be necessary to enter all penstrokes into the computer for entry of the character, since the desired character may be determined to be a statistically significant potential match before all penstrokes are entered into the computer.

Further in accordance with the restrictive direct geometric mode, some 20 margin of error may be designed into the system embodying the present invention for stylistic variations or differences of opinion in the placement of penstrokes within a particular character. For instance, it may be appropriate to represent a given penstroke by more than one particular key pair, due to stylistic variation or like differences.

25 FIG. 5B depicts key pairs corresponding to penstrokes for entering the character of FIG. 2 according to the non-restrictive indirect geometric mode of entry which may be used in conjunction with the two-key penstroke entry method of the first embodiment, as stated above. According to the non-restrictive indirect geometric mode, key pairs are selected which are positioned relative to each other

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corresponding to the penstroke endpoints, but the key pair need not necessarily be spatially oriented on the keyboard in the same manner as the penstroke endpoints are spatially oriented within the character. In other words, the position of the first key with respect to the second key corresponds to the position of the first penstroke 5 endpoint with respect to the second endpoint (i.e., corresponding relative positioning).

The non-restrictive indirect geometric mode tends to recognize more key pairs which may be chosen to represent a particular penstroke, than the restrictive direct geometric mode. In fact, the restrictive direct geometric mode may be 10 thought of as a subset of the non-restrictive indirect geometric mode, since the restrictive direct geometric mode allows only those key pairs which are both relatively and spatially positioned the same as the endpoints, while the non-restrictive indirect geometric mode allows key pairs which are relatively positioned the same as the endpoints.

15 Since the non-restrictive indirect geometric mode does not require key pairs which are correctly spatially oriented, there may be several key pairs which suffice as the keys chosen to represent the endpoints of a penstroke. For instance, using the non-restrictive indirect geometric mode, penstroke "a" of FIG. 2 may be entered by selecting the key pair (7,1) from the keypad illustrated in FIG. 1B, where key 20 pair (7,1) is both relatively and spatially oriented correctly. Alternatively, the penstroke "a" may be entered by selecting any of key pairs (8,2), (9,3), (7,4), (5, 2), (4,1) or (8,5), or other key pairs which are positioned vertically relative to each other in the same manner as the endpoints of penstroke "a." In other words, the non-restrictive indirect geometric mode uses key pairs where the two keys are 25 correctly positioned relative to each other, but are not necessarily spatially oriented on the keyboard in the same manner as the penstroke endpoints are spatially oriented within the character.

To illustrate that the key pairs chosen according to the non-restrictive indirect geometric mode need not be spatially oriented the same as the penstroke,

five exemplary key pairs are depicted in FIG. 5B for each of the five penstrokes of the character illustrated in FIG. 2. Many other key pairs may be chosen as well, according to the non-restrictive indirect geometric mode, so long as the key pairs are relatively oriented the same as the penstroke endpoints. Thus, the penstrokes of 5 the Chinese character depicted in FIG. 2, could be entered into a computer using the non-restrictive indirect geometric mode of the present invention by typing in, for example, the ten-digit number string "7173468213," or by typing in "8275797179," or "7186788245," or any of many other alternative ten-digit number strings. Of course, as mentioned above, it may not be necessary to enter all penstrokes of a 10 character into the computer, since the desired character may be recognized as a potential match before all penstrokes have been entered.

FIG. 5C depicts the keys corresponding to penstrokes for entering the character of FIG. 2 according to the second embodiment of the present invention. According to the second embodiment, a user enters the penstrokes of a desired 15 character by depressing a single key for each penstroke to be entered. The user enters the key corresponding to the relative orientation of the second of the two penstroke endpoints. The first of the two endpoints is understood to be represented by a designated key. The designated key may be set by default or may be chosen by the user. The FIG. 5C illustrates the keys to be depressed for the case in which the 20 "5" key of the FIG. 1B keyboard is the designated key which represents the first endpoint of each keystroke. For instance, since stroke "a" is made in a top-to-bottom motion, the "2" key is depressed to represent this penstroke, the "2" key representing the second endpoint being oriented directly below the "5" key which represents the first endpoint. Similarly, the "3" key represents penstroke "b," 25 because the "3" key has the same relative orientation to the "5" key as the second endpoint of penstroke "b" has to the first endpoint. Thus, all penstrokes of the Chinese character depicted in FIG. 2, can be entered into a computer using the second embodiment of the present invention by typing in the five-digit number

string "23626," in the instance where the "5" key is selected as the designated key representing the first endpoint.

Alternative embodiments exist in which keyboard keys other than the 5 key are selected as the designated key representing the first endpoint. For example, to 5 more easily facilitate left handed character entry on the keyboard of FIG. 1C, the "D" key could be selected as the designated key representing the first endpoint. Another alternative one-key entry embodiment exists in which a key is entered for the first of the two endpoints, with the second endpoint being represented by a designated key. As a further alternative, the arrow keys of a keyboard can be used 10 to indicate the motion of the penstroke. For instance, according to this embodiment, penstroke "a" of FIG. 2 is entered by depressing the "down" arrow key. Similarly, penstroke "b" is entered by depressing both the "left-to-right" arrow key and the "down" arrow key. Since entry of two keys is required to define penstroke "b", these two keys can either be depressed simultaneously, or another 15 predefined key (e.g., the "space bar" or "enter" key) can be depressed to indicate that both the "left-to-right" and the "down" arrow keys represent the same penstroke, instead of two different penstrokes.

It will be appreciated by those skilled in the art that the present invention can be embodied in other specific forms without departing from the spirit or essential 20 characteristics thereof.

WHAT IS CLAIMED IS:

1. A method for inputting a desired character via a keyboard, the method comprising the steps of:
 - 5 entering a key of the keyboard to represent a feature associated with a penstroke of the desired character;
 - determining potentially matching characters in response to the key entered;
 - and
 - selecting the desired character if the desired character is among the
- 10 potentially matching characters.
2. The method of claim 1, wherein the feature is an endpoint associated with the penstroke of the desired character.
- 15 3. The method of claim 2, further comprising a step of:
 - entering an other key of the keyboard to represent an other endpoint associated with the penstroke.
4. The method of claim 3, further comprising a step of:
 - 20 entering an additional key if the penstroke has a curve, the additional key being representative of the curve in the penstroke.
5. The method of claim 3, wherein a relative position of the key entered with respect to the other key entered corresponds to a relative position of the
- 25 endpoint with respect to the other endpoint.
6. The method of claim 5, wherein a spatial position of the key entered and the other key entered with respect to the keyboard corresponds to a spatial position of the endpoint and the other endpoint with respect to the desired character.

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7. The method of claim 1, further comprising a step of:
repeating said step of entering a key to enter an other penstroke if the desired character is not among the potentially matching characters determined.

5 8. The method of claim 7, wherein the penstroke entered corresponds to a first written penstroke in a customary order of writing the desired character, and the other penstroke entered corresponds to a second written penstroke in the customary order.

10 9. The method of claim 1, wherein said step of determining potentially matching characters step comprises the step of:
determining whether the potentially matching characters are statistically significant with respect to a predetermined threshold.

15 10. The method of claim 1, wherein said step of selecting the desired character comprises the steps of:
displaying the potentially matching characters; and
choosing the desired character from amongst the displayed potentially matching characters.

20 11. The method of claim 2, wherein a designated key represents an other endpoint associated with the penstroke.

25 12. The method of claim 3, further comprising steps of:
displaying to a user a penstroke representation based upon the key entered and the other key entered; and
adjusting the penstroke representation by the user to more closely represent the penstroke of the desired character.

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1	2	3
4	5	6
7	8	9
*	0	#

FIG. 1A

NUM LOCK	/	*	-
7	8	9	
4	5	6	+
1	2	3	
0			E

FIG. 1B

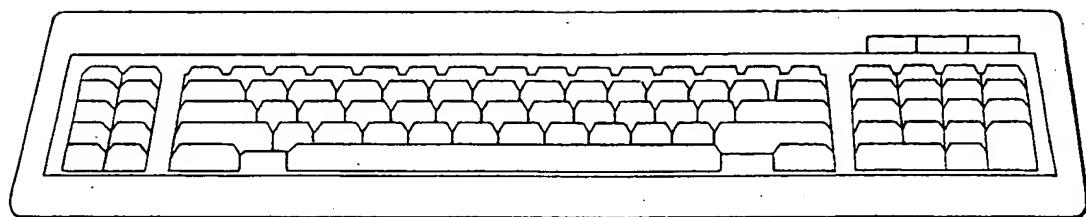


FIG. 1C

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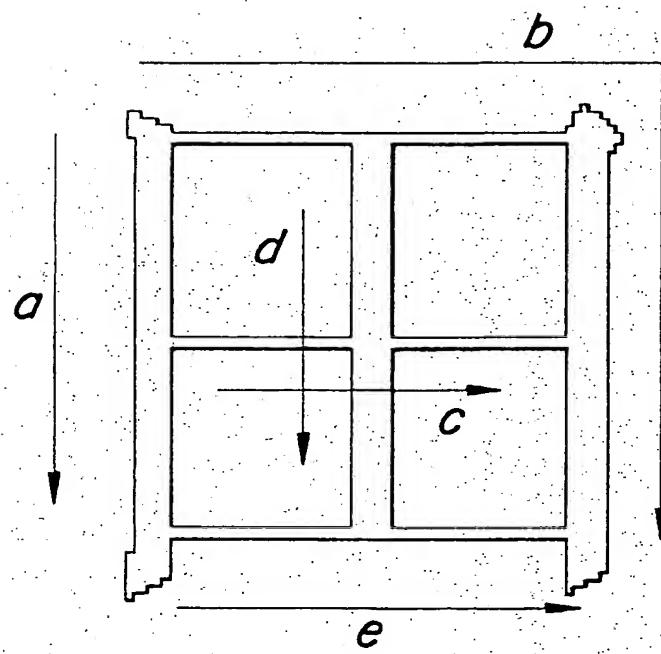


FIG. 2

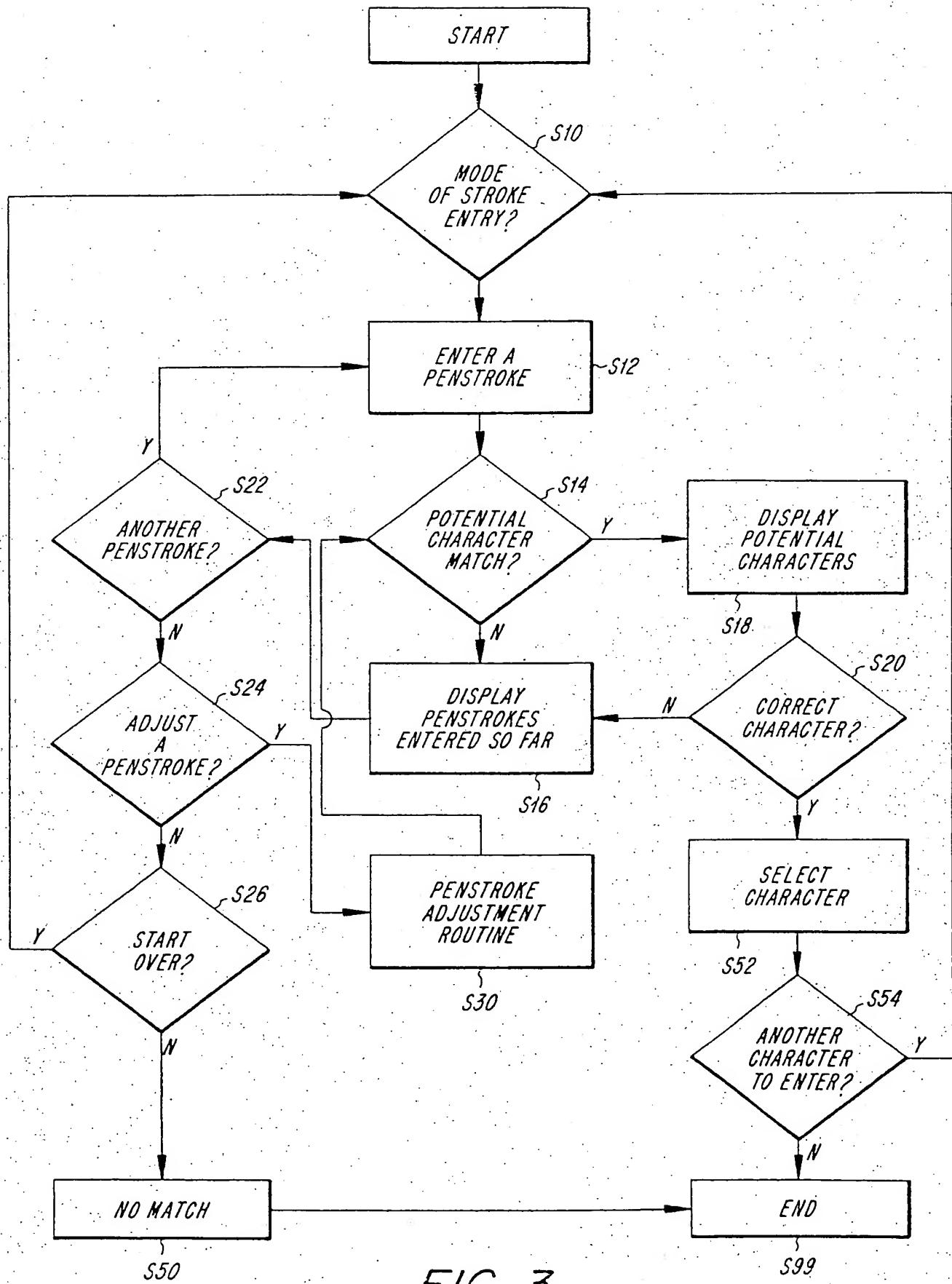


FIG. 3

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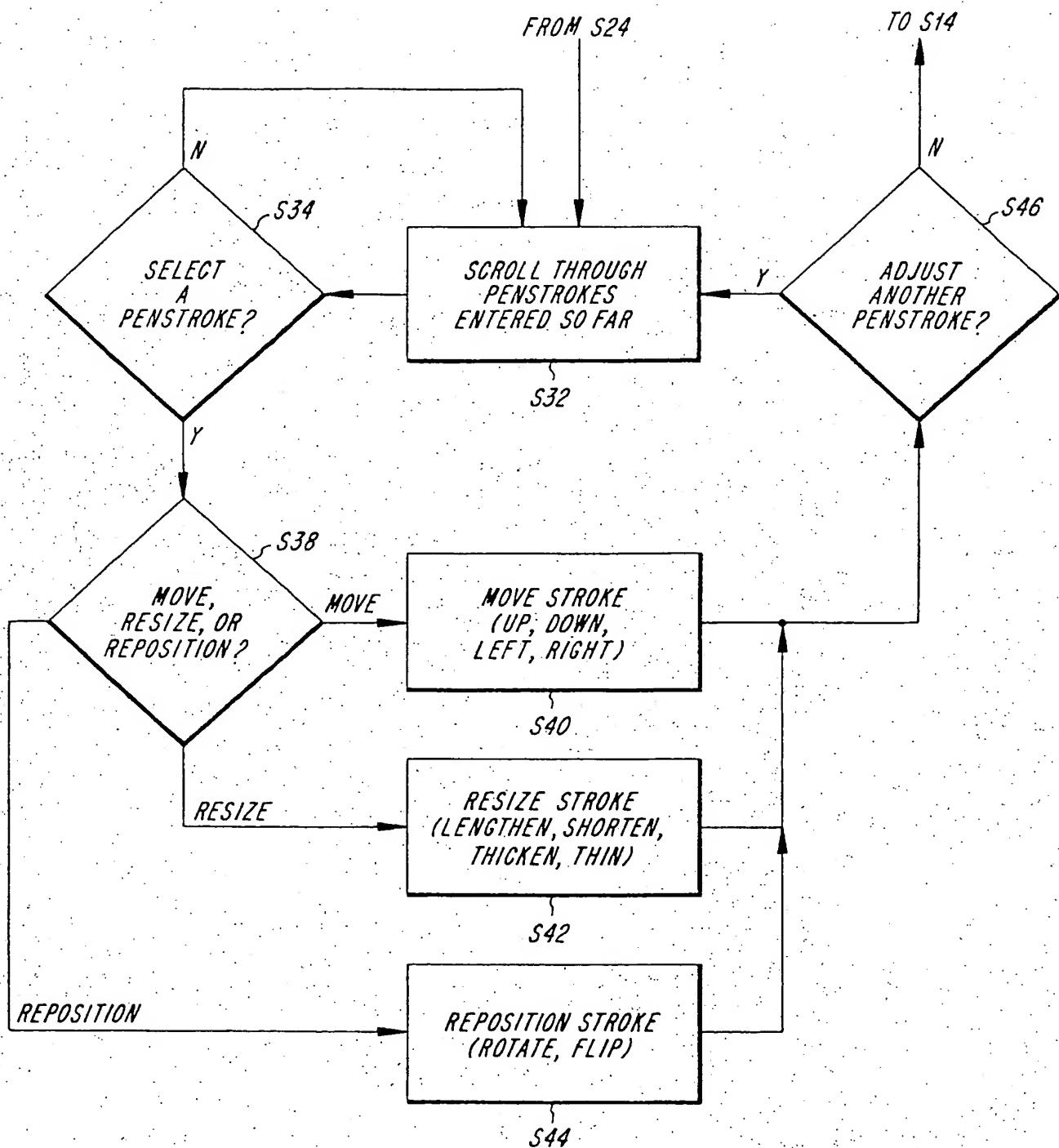


FIG. 4

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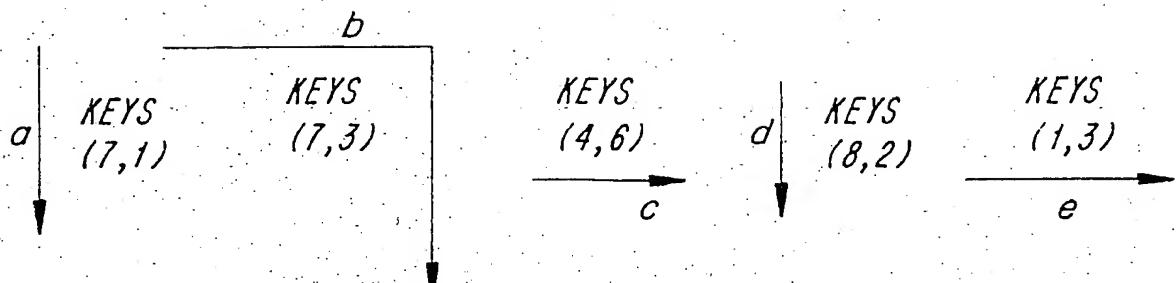


FIG. 5A

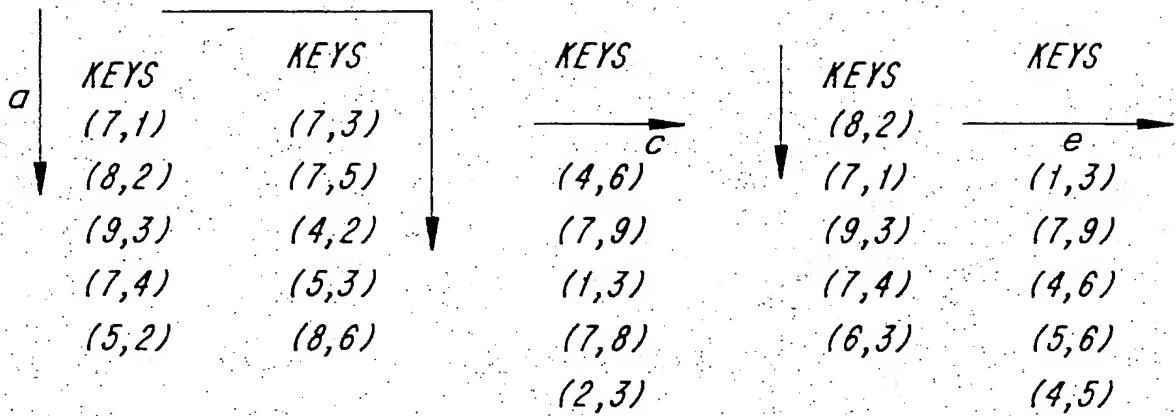


FIG. 5B

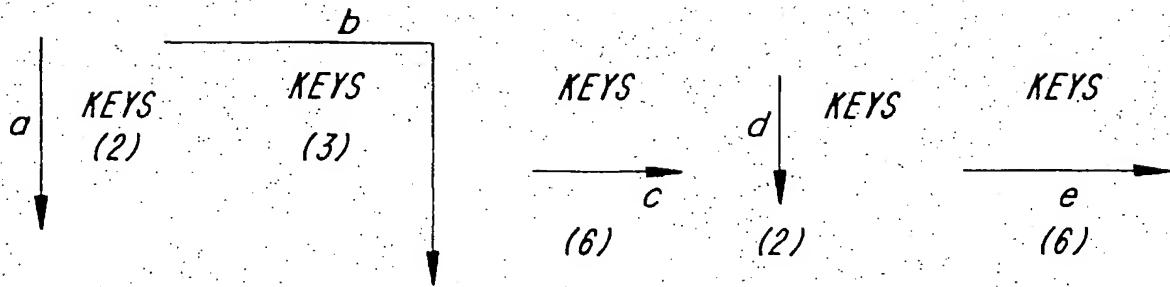


FIG. 5C

INTERNATIONAL SEARCH REPORT

Internat'l Application No
PCT/SE 00/01525

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06F3/00 G06F3/023

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06F H03M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

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Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

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- *O* document referring to an oral disclosure, use, exhibition or other means
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T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the international search

2 November 2000

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INTERNATIONAL SEARCH REPORT

Internal Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Internal ref Application No

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